

**Type A Accident  
Investigation Board Report  
of the February 13, 1997  
Welding/Cutting Fatality  
at the  
K-33 Building, K-25 Site  
Oak Ridge, Tennessee**

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## **1.0 INTRODUCTION**

### **1.1 BACKGROUND**

On February 13, 1997, at approximately 11:10 a.m., a welder (referred to as "the Welder") using a cutting torch at the K-33 Building, Oak Ridge K-25 Site, Oak Ridge Reservation, was fatally burned after being totally engulfed in flames when his anti-contamination coveralls and blue general-purpose coveralls burned.

*On February 13, 1997, a welder using a cutting torch was fatally burned when his anti-contamination coveralls caught fire.*

On February 14, 1997, Tara O'Toole, M.D., M.P.H., Assistant Secretary for Environment, Safety and Health, U.S. Department of Energy (DOE), appointed a Type A Accident Investigation Board to investigate the accident in accordance with DOE Order 225.1, *Accident Investigations* (see Appendix A).

### **1.2 FACILITY DESCRIPTION**

Contractor activities at the K-33 Building are managed by the DOE Oak Ridge Operations Office (OR). The facility in which this accident occurred is under the programmatic direction of the DOE Office of Environmental Management (EM). The current management and operating (M&O) contractor for the K-25 Site is Lockheed Martin Energy Systems, Inc. (LMES).

The K-25 Site, of which K-33 is a part, covers roughly 5,000 acres, or 14 percent of the Oak Ridge Reservation, and is approximately 13 miles from downtown Oak Ridge, Tennessee. The Site includes buildings that used the gaseous diffusion process to enrich uranium in the U<sup>235</sup> isotope. In 1985, the gaseous diffusion process facilities were placed on standby and were shut down in 1987. Since 1987, efforts have been under way to evaluate cost-effective methods to decontaminate and decommission these facilities, while minimizing waste generation and the potential for future environmental issues.

Almost 90 percent of the available building space is currently

*Nearly all of the available building space at the K-25 Site is either undergoing, or is planned for, decontamination and decommissioning.*

undergoing, or is planned for, decontamination and decommissioning (D&D). Current activities of the K-25 Site gaseous diffusion process facilities principally involve passive storage of waste drums, surveillance and maintenance activities, and occasional removal of process equipment for shipment to operating gaseous diffusion plants.

K-33, the largest of the gaseous diffusion process facilities, occupies approximately 32 acres in the northwest section of the K-25 Site. Until 1985, the K-33 Gaseous Diffusion Building was used for uranium enrichment. Significant amounts (greater than 1 kg) of enriched uranium remain deposited in process equipment throughout the building. To minimize the risk of a nuclear criticality reaction, the deposits have been isolated. Hazardous and mixed wastes are stored in the building. There are few workers in the building on a daily basis.

The basic equipment unit in a gaseous diffusion plant, referred to as a stage, has three main components: an electric-motor-driven compressor, a converter containing a very large surface area of semi-permeable barrier material, and the process gas heat exchanger. A grouping of stages is referred to as a cell. The related piping systems connect eight equal-size stages to form a cell, which is enclosed in sheet metal. K-33 contains 640 stages grouped into 80 cells. The cells are grouped into units, and the units constitute a cascade. Exhibit 1-1 shows several of the remaining six stages comprising Cell 7 of K-33 at the time of the accident.

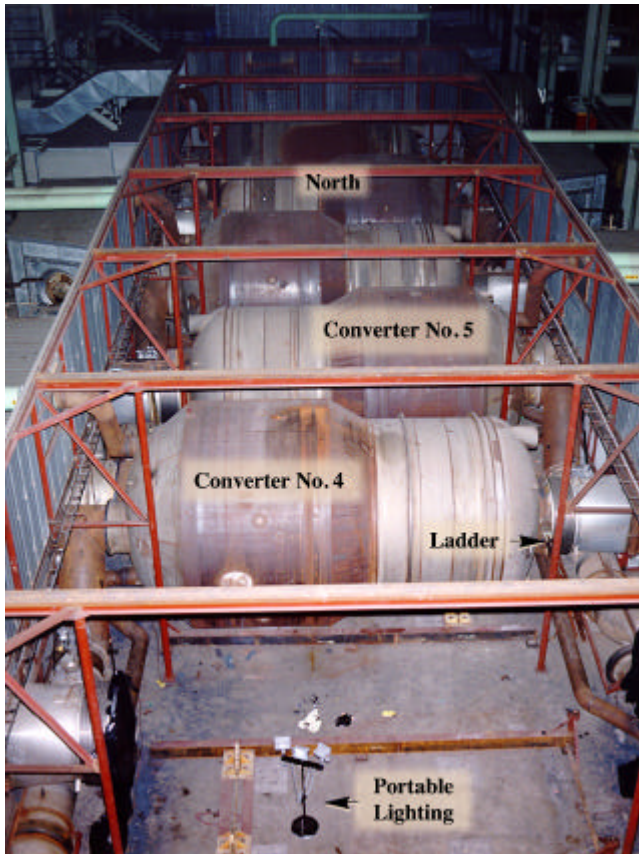
### 1.3 SCOPE, CONDUCT, AND METHODOLOGY

The Board commenced its investigation on February 17, 1997, completed the investigation on March 14, 1997, and submitted its findings to the Assistant Secretary for Environment, Safety and Health on March 19, 1997.

The **scope** of the Board's investigation was to review and analyze the circumstances to determine the accident's cause(s). The Board also evaluated the adequacy of the DOE and contractor's safety management system and work control practices.

*The K-33 Building gaseous diffusion process is shut down; however, significant amounts of enriched uranium remain.*

*The Type A Accident Investigation began on February 17, 1997.*



**Exhibit 1-1. View Looking North in Cell 7,  
K-33 Building**

The **purposes** of this investigation were to determine the causes of the accident, including deficiencies, if any, in safety management systems and to assist DOE in understanding lessons learned to promote safety improvement and to reduce the potential for similar accidents.

The Board conducted its investigation, focusing on management systems, using the following **methodology**:

- Facts relevant to the accident were gathered through interviews and through document and evidence reviews.
- Burn tests of clothing similar to that worn during the accident were conducted.

- Event and causal factors charting,<sup>1</sup> along with barrier analysis<sup>2</sup>

*The investigation determined the causes of the accident and developed judgments of need to prevent recurrence.*

and change analysis,<sup>3</sup> was used to provide supportive correlation and identification of the accident's causes.

- Based on analysis of the data, judgments of need for corrective actions to prevent recurrence were developed.

## **2.0 FACTS AND ANALYSIS**

### **2.1 ACCIDENT DESCRIPTION AND CHRONOLOGY**

#### **2.1.1 Background and Accident Description**

The accident occurred at approximately 11:10 a.m. on Thursday, February 13, 1997, at the K-33 Building when the Welder, who was using a cutting torch, became engulfed in flames. The Welder was employed by LMES. The work at the K-33 Building involved removing six converters from Cell 7 for shipment to Portsmouth/Paducah as spare parts. This work began February 8, 1997, and was scheduled to be completed by the end of March 1997, prior to the award of a contract under the re-industrialization program at K-25.

*The accident occurred at approximately 11:10 a.m. on February 13, 1997, in Cell No. 7.*

The scene of the accident was within Cell 7 of the K-33 Building (see Exhibit 1-1). A planning meeting for the removal of three "000" converters from K-33, Unit 8, Cell 7 was held on January 27, 1997 (four days after the Safety Work Permit was issued), and a subsequent Maintenance Job Request was issued on January 27, 1997. The cell roof, two converters, a small side panel on the east wall adjacent to Converter 3, and a small side panel on the west side adjacent to Converter 5 had already been removed from Cell 7 at the time of the accident. As a result of the work done in 1996 at K-31 [referred to as the Small-Scale Metal Recycle Project (SSMRP)], plus earlier extensive equipment replacement activities during operations prior to 1985, LMES had classified the removal

*The removal of equipment from the cells was considered routine maintenance, and no specific job hazard analysis was prepared beforehand.*

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<sup>1</sup> Charting depicts the logical sequence of events and conditions (causal factors) that allowed the events to occur.

<sup>2</sup> Barrier analysis reviews hazards, the targets (people or objects) of the hazards, and the controls or barriers that management control systems put in place to separate the hazards from the targets. Barriers may be administrative, physical, or supervisory/management.

<sup>3</sup> Change analysis is a systematic approach that examines barrier/control failures resulting from planned or unplanned changes in a system.

of converters and associated equipment from K-33 for this job as “routine maintenance.” Thus, no task-specific work plan or Job Hazards Analysis was prepared. The following permits were prepared: Safety Work Permit (January 23, 1997), Radiological Work Permit (February 7, 1997), and the daily Welding/Burning/Hotwork Permit<sup>4</sup> for February 13, 1997. The workers initiated K-33 converter removal on February 8, 1997.

The job was about a week behind schedule, and the crew worked overtime on Saturday, February 8, 1997, and on Wednesday evening, February 12, 1997.

On February 13, 1997, the Service Supervisor (the first-line supervisor responsible for the workers on the job and conduct of the work) was not present at the daily safety meeting held by the welders at 7:00 a.m. Although not present at the meeting, the Service Supervisor signed a Burning Permit for the work to be conducted in the cell for that day. No designated fire watch was assigned on the permit.

*The Service Supervisor signed the work permit, but did not assign a fire watch.*

Four maintenance mechanics arrived at the K-33 Building around 7:50 a.m., electronically signed the Radiological Work Permit (RWP No. 970067), dressed in anti-contamination clothing, entered Cell 7, and prepared to remove Converter 3. They left the building for a short time because Converter 3 was not ready to be lifted out of the cell. They returned to the maintenance building for morning break at 8:30 a.m. The maintenance mechanics returned, and the welders first arrived at the K-33 Building at around 9:30 a.m. All workers except the Welder signed the Radiological Work Permit, dressed in anti-contamination clothing, and entered the radiological area. The Welder electronically signed the Radiological Work Permit at 9:57 a.m. and, dressed in anti-contamination clothing, entered the radiological area, arriving at Cell 7 at 10:35 a.m. After talking with radiological control technicians, he entered Cell 7 at about 10:55 a.m.

At the time of the accident, the Welder was wearing one set of underwear, one set of 100 percent cotton blue general-purpose coveralls, two sets of 100 percent cotton yellow anti-contamination coveralls, one pair of cotton liner gloves, one pair

*At the time of the accident, the Welder was wearing three sets of coveralls, three pairs of gloves, four covers over safety shoes, a skull cap and hood, a personal air monitor, and a full-face respirator with an attached welding*

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<sup>4</sup> Hereafter, “Welding/Burning/Hotwork Permit” is referred to as “Burning Permit.”

of latex gloves, one pair of terry cloth welder gloves, one pair of safety shoes, one pair of plastic booties, two pairs of plastic shoe

covers (scuffs), one pair of rubber totes, a skull cap, a hood, a full-face respirator, a personal air monitor, and a welding mask clipped to the respirator. Exhibit 2-1 shows a similarly outfitted welder.

#### **Exhibit 2-1. Similarly Outfitted Welder**

Maintenance mechanics had finished moving Converter 3 out of the



cell and were doffing their outer layer of anti-contamination coveralls at the contamination boundary control station just outside Cell 7. One welder (Welder 2) was in Cell 7 working on the northwest side of Converter 5. Another welder (Welder 3), upon leaving Cell 7, noticed that the Welder was changing his torch tips. The Welder then began to cut the clamps on the east end of Converter 4. Neither Welder 2 (in the cell) nor Welder 3 (out of the cell) was in direct sight of the Welder.

The Welder was using a cutting torch to remove one of the six remaining process converters and, at the time of the accident, was working on a ladder at the east end of Converter 4 (see Exhibit 2-2).

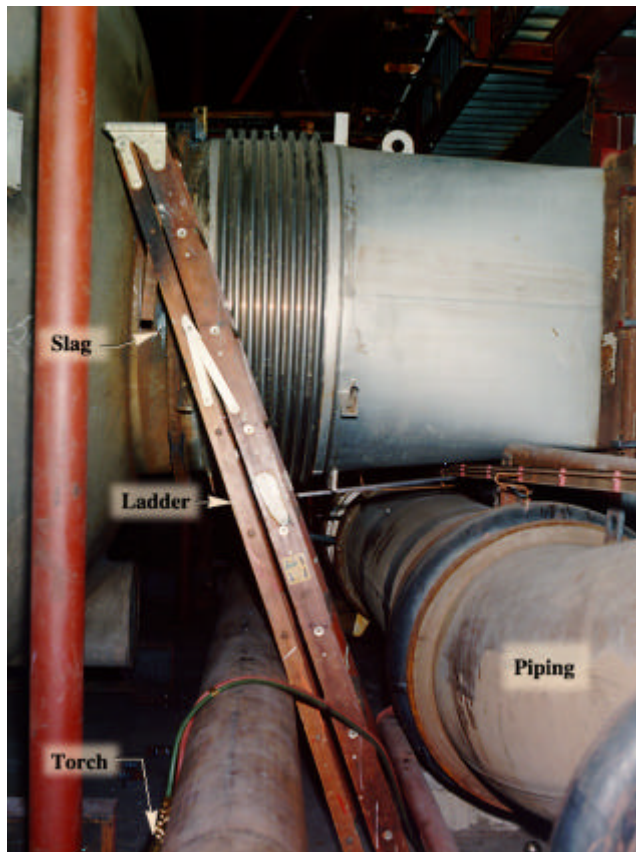
mask.

*The Welder was basically working alone, out of sight of other workers.*

No access panels had been removed from the east wall adjacent to Converter 4.

#### **Exhibit 2-2. East End of Converter 4**

No direct account of the accident was available, since there were no



eyewitnesses. The Board has reconstructed the most probable sequence of events (through extinguishing the flames by a maintenance mechanic), using the physical evidence, interviews, and results of burn tests. A schematic of the inside of Cell 7, the relative location of personnel, and the path of the Welder after he became engulfed in flames is shown in Figure 2-1. At approximately 11:09 a.m., a piece of hot slag or a spark ignited the Welder's anti-contamination coveralls at or somewhat below his left knee. At approximately 11:10 a.m., the Welder felt heat and noticed that the clothing on his left leg was on fire. The Welder attempted to put out the flames while he was still on the ladder. He came down the ladder, moved to the south side of Converter 4, and screamed for help while still trying to put out the flames. He removed his mask and respirator and screamed for help again. Because the respirator muffled the first scream, only the second scream was recognized as a distress call by one of the four maintenance mechanics outside Cell 7.

*The Welder's outer coveralls ignited, but he did not know it for perhaps a minute or more. His first call for help was muffled by his respirator.*

Two maintenance mechanics requested permission from a radiological control technician to enter Cell 7. One of them turned off the oxygen and acetylene cylinders of the Welder's torch, located outside Cell 7, while the other entered Cell 7, crawled under the piping, and saw the Welder, who was now standing on the cell floor northwest of Converter 1, totally engulfed in flames. While attempting to help the Welder remove his burning clothes, the maintenance mechanic's gloves caught on fire, so he stepped back and extinguished his own gloves by rubbing them together. At this point, the Welder began to run in a path that took him to the northeast side of Converter 1, where he fell to his knees on the floor of the cell (see Figure 2-1). The maintenance mechanic picked up a dry-chemical fire extinguisher and extinguished the flames at approximately 11:12 a.m.

*When a worker entered the cell to help, the Welder was engulfed in flames. After the worker's gloves briefly caught fire, he extinguished the Welder's flames with a dry-chemical fire extinguisher.*

### **2.1.2 Chronology of Events**

Figure 2-2 summarizes the chronology of significant events.

### **2.1.3 Emergency Response and Investigative Readiness**

The Welder's burn injuries generated a response involving coworkers, Fire Department personnel, and Medical Facility professional staff. Pull-box and Station Nine calls brought Fire Department responders within minutes. Under difficult, restricted access conditions, first responders and follow-on Fire Department Emergency Medical Technicians rendered first aid to the Welder and extracted him on a stretcher from the K-33 Building. K-33 Building and Cell 7 layout obstacles prolonged patient removal. Medical personnel (doctor and nurse) examined him outside the building and treated him on the ambulance run to Methodist Medical Center Emergency Department. An intravenous catheter was inserted in the left wrist, and fluids were administered en route. The Welder was kept warm to avoid burn-related hypothermia and given oxygen to breathe. He was loaded aboard the ambulance at 11:46 a.m. (about 35 minutes after the accident), arriving at Methodist Medical Center in Oak Ridge at noon.

*Obstacles in the cell and building hampered removal of the Welder to the ambulance.*

Figure 2-1. The Welder's Location and Movement Within Cell No. 7

